Control: Digitality as Cultural Logic
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(p.xiii) Introduction

The Computer as Metaphor

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The postindustrial society. The information economy. The third wave. Late capitalism. Post-Fordism. The network society. Neoliberalism. The new spirit of capitalism. Empire. The desire to account for the present socioeconomic moment has led to what can only be described as a frenzy of periodization. And this frenzy of periodization can only be understood as a symptom of an episteme in which the diffusion of exploited labor across the social fabric in the overdeveloped world and ever-growing rates of exploitation, expulsion, incarceration, and destruction in the fissures and at the margins of this world exist as features of a sociocultural-economic system in which the supposedly frictionless movement of information functions as a sovereign concept.[1] Each of the periodization theories listed at the beginning of this introduction grapples with one or more components of a historical arc that begins to coalesce after World War II, intensifies through the social movements of the 1960s and the currency and oil crises of the 1970s, and continues to unfold today. This historical trajectory can be analyzed along a number of different vectors: from industrial dynamics to the specific, technologically mediated practices undergirding the most recent transformations in modes of production; from new and emerging types of commodity to newly flexible and dynamic organizational diagrams; from defined political programs implemented through state legislation to the decline of various forms of sovereignty (even if, as described in Michael Hardt and Antonio Negri's book *Empire*, these return under a new, distributed, and swarmlike form).

But what kinds of historical and representational forces are at work behind this desire for periodization? What might emerge if one looks through all of these efforts to distinguish the current historical moment from its preceding era—broadly put, the period of industrial modernity, factory-line production, disciplinary institutions (the school, the hospital, the prison), national sovereignty, and so on—in order to locate the conditions of knowledge that ground them? The accounts contained in *The* **(p.xiv)** *Post-industrial Society*, *The Rise of the Network Society*, and *The New Spirit of Capitalism*,[2] for example, are thorough enough when it comes to describing the characteristics of certain practices of production and distribution, making neat and tidy distinctions between distinctive technological paradigms, observing new organizations of labor time, or tracing the changing dynamics of family life (at least, they are thorough enough

when it comes to the Global North). But achieving this rigorous definition of the present and its distinction from the past comes at a cost. Asserting the radical difference between present and past without examining the contingency of the conceptual frameworks, spatial diagrams, and metaphors one uses in order to do so risks obscuring those shifts in the conditions of knowledge that are required for diffuse groups of individuals, institutions, and systems to desire, conceptualize, and enact such differences in the crucible of history.

Returning to the periodizing concepts listed earlier, one might note that several of them are grounded in specific technological substrates—automation and self-regulating machines in general, and electronic computers more specifically. It is tempting, then, to begin this inquiry from the specific forms and uses of computing machines. But if these substrates can be briefly held to one side, certain recurring motifs and structures can be seen to constitute a deep-rooted cultural logic with widespread implications for concepts as fundamental (and as disputed) as identity, thought, and the social. In other words, each of the major periodization theories centered on the late-twentieth and early twenty-first centuries nods more or less extensively to the electronic digital computer and its associated practices, but they are not histories of technology, nor are they software guides or coding manuals or guides to the effective integration of computer systems within given institutions. These accounts are concerned not with computer technologies themselves but rather with the constellation of socioeconomic transformations that surround the emergence and present ubiquity of the electronic digital computer. The questions raised by this perspective—about how thought and practice relating to the management of society have become imbricated with but not simply determined by particular technologies (because if the latter were true, such wrangling over specific features of the present period would not be necessary; one could simply itemize the ways in which computers are used in factories, offices, trading floors, schools, prisons, and so on)—are central to locating a cultural logic of the so-called information age.

Control: Digitality as Cultural Logic addresses the emergence and normalization of the conditions of knowledge that (1) make concepts such as “the information economy” thinkable and (2) determine the deleterious effects **(p.xv)** of these concepts when they are turned loose on material social spaces, from factories and offices in the overdeveloped world to the vast spaces of dispossession that both undergird the social conditions of these overdeveloped spaces and persist in their interstices. Because these conditions emerge in complex, uneven ways, and because they are produced socially and culturally as well as technically, they cannot necessarily be grasped as a totality or tracked in a linear fashion. The book thus seeks to locate their emergence across three intertwined threads. The first consists of the roots of a relationship between information, labor, and social management that emerged in nineteenth-century political economy, technology, and governmentality and became established as norms in the second half of the twentieth century; the second consists of the development and diffusion of human–computer metaphors in the middle decades of the twentieth century; and the third observes the breadth and penetration of these informatic principles in certain socioeconomic and cultural practices in the late-twentieth and early twenty-first centuries.

What kinds of assumptions are required to understand people and their multiple, heterogeneous social interactions in terms of digital information and its processing and transmission? What historical processes would be necessary to operationalize these assumptions at the level of social and political orthodoxy? And what would be the socioeconomic and cultural implications of such a vision of the world functioning as an unmarked norm? These are the questions that guide the following pages. Setting out to answer them requires a method that draws on critical theory,

media theory, and the history of science. It also requires an engagement with the possibility that many of the forms of violence that exist under the present arrangement of global political economy are not accidents or problems simply waiting to be solved under the newer, more flexible, communicative, and connected economic mode, but rather features that are internal to the same logic that makes ideas of society as a communication network or an information-processing system possible in the first place.

The logic under which social worlds are reconceptualized as information-processing systems is here defined as *control*. Control, as it is theorized in this book, describes a set of technical principles having to do with self-regulation, distribution, and statistical forecasting that is extended to the conceptualization of sociality through a series of subtle historical transformations. As such, it also describes the episteme grounding late capitalism, a worldview that persists beyond any specific device or set of practices. Control, in this sense, must be understood as fundamentally digital but not necessarily confined to social practices that are directly mediated by **(p.xvi)** electronic digital computers. A prefatory note is thus required to demonstrate the ways in which the concept of control pursued here encompasses but also departs from a more conventional version of the concept that has to do with technical principles of information processing and their deployment in industrial production, the emergence of knowledge work, biology, and materialist psychology, among other fields.

The existing, materialist concept of control from which this book departs describes a set of principles concerning self-regulation in animals and machines as well as a paradigm for technical and social organization gaining prominence in the overdeveloped countries after World War II.[3] Although interest in this notion of control can be seen to bloom after the publication of Norbert Wiener's book *Cybernetics: Control and Communication in the Animal and the Machine* in1948, the principle of technological self-regulation must be situated in a broader history. This history encompasses at least the use of nondigital systems such as float regulators in ancient Greece, James Watt's flyball governor for steam engines of 1788, and James Clark Maxwell's landmark paper "On Governors" of 1868. The words used to name each of these technologies must be seen as conveying more-or-less explicit political valences—*control* itself derives from the French term *contre-rolle* (counter-roll), a copy of a legal document used to verify the authenticity of the "original," and the implications of the word *governor* scarcely require elaboration. In analyses of control as material self-regulation, however, this political valence is generally rendered as coincidental to the function of particular apparatuses and practices.[4]

Although this historical context must be accounted for, it is clear that much of the conceptual and explanatory power of control in the twentieth and twenty-first centuries stems from its interconnection with the electronic digital computer. Because of this interconnection, studies of control as self-regulation tend to encompass technical procedures of industrial automation, informatic capture, distributed command, and technical management—modes of intensified efficiency and regulation of production that characterize the socioeconomic period described in so many ways in the texts listed at the start of this introduction. This understanding of control as a primarily technosocial principle undergirds historical studies such as James R. Beniger's commanding work *The Control Revolution*. Here Beniger sets out a periodization theory that situates technological control as the source of a third industrial age consisting of

> a complex of rapid changes in the technological and economic arrangements by which information is collected, stored, processed, and communicated, and through **(p.xvii)** which formal or programmed decisions might affect social control. From its origins in the

> last decades of the nineteenth century, the Control Revolution has continued unabated, and recently it has been accelerated by the development of microprocessing technologies. In terms of the magnitude and pervasiveness of its impact upon society, intellectual and cultural no less than material, the Control Revolution already appears to be as important to the history of this century as the Industrial Revolution was to the last.[5]

Beniger's account of control as a set of technical processes that directly affect social and economic transformations is rich and compelling, covering developments in biology, psychology, and linguistics as well as technical practices in industrial production and the collection, storage, and processing of information. This aspect of control is central to the analysis of cultural logic given here. But the sense in which the term *control* is used in this book departs in important ways from those analyses that center on information technologies and their direct use or even on the wider (but still more or less direct) sociopolitical implications of these technologies and their uses. In short, this book is as concerned with control's fuzzier sociocultural valences as it is with the technical and organizational functions from which these valences are derived. These sociocultural aspects operate in concert with control's surface technical and organizational elements, and they both shape and obscure many of its more troubling effects.

At this point, it must be acknowledged that a sociocultural valance of control *can* be observed in Beniger, but in the form of an assumption that undergirds his method rather than as an object of study in itself. For Beniger, the importance of the control revolution stems from its fundamental commensurability with the biological and social structure of humanity:

> Because societies [like living organisms] must also be concrete open systems if they are to sustain their organization against the progressive degrading of their collective energy, the view of organisms as concrete open processing systems applies equally to their social aggregates. The essence of human society, in other words, is its continuous processing of physical throughputs, from their input to the concrete social system to their final consumption and output as waste.… Unlike living organisms, however, *social* systems are made up of relatively autonomous components—individuals, families, groups, organizations—that can act for different and even cross-purposes. Because system processing must depend on exchanges among these individual components, the need for their coordination and control means that information processing and communication will account for a greater proportion of matter and energy flow than they do in single organisms. The actual proportion will depend on several factors, including size of the population and its spatial dispersion, complexity of organization, and volume and speed of processing, among others.[6]

(p.xviii) Beniger's application of principles derived from the electronic digital computer to fundamental conceptualizations of individual human actors and social groups is symptomatic of a historical shift that the political scientist Karl Deutsch described in 1963 as moving the "center of interest from drives to steering, and from instincts to systems of decisions, regulation, and control."[7] The wider logic of control that grounds informatic capitalism, then, reaches beyond the direct social and technological practices whose growth, beginning in the late nineteenth century, is accounted for by writers such as Beniger, Wiener, and David Mindell. The logic of control as episteme describes a wholesale reconceptualization of the human and of social interaction under the assumption—visible in Beniger's work from the 1980s as well as in the dominant social, economic, and political practices of the present—that information storage, processing, and transmission (as well as associated concepts such as "steering" and

"programming") not only constitute the fundamental processes of biological and social life but can be instrumentalized to both model and direct the functional entirety of such forms of life.

Where for writers such as Beniger (and for economists such as Gary Becker and Friedrich Hayek) this principle of control serves as an objective ground from which further analysis can be conducted, in this book it emerges as an object of contestation. It describes a deleterious process though which, as Tiqqun put it, steering (a term that can be taken as a synonym for control in all of its technical, political, and cultural valences) becomes the *guiding metaphor for all human activity.*[8] Control, this book argues, should be understood as the logical basis of a worldview that imbricates literal practices of computation, the new organizational and infrastructural concepts these practices facilitate, and metaphors derived from the electronic digital computer and its processes with a system of value production that can produce profit only by exploiting and dispossessing human life.

For this epistemic movement to become thinkable requires a turn toward digitality not only as a logical-technical substrate through which certain machines might operate but also as a predominant logical mode with which to address both individual social actors and the body of interactions between these actors that can be dubbed "society." Digitality can be placed in the category of practices that Bernard Stiegler describes as proceeding through grammatization, "the process through which the flows and continuities which weave our existences are discretized."[9] The digitality that informs control, though, goes beyond the other practices of grammatization Stiegler addresses (writing, the rationalization of production through machine tools) in that it no longer presents discretized representations as **(p.xix)** systems that imply a more continuous or complex world behind them; instead, the logic of control posits its objects as already fundamentally discrete, at least in every way that can possibly matter. To be clear, what is being formulated here is not an argument in favor of any specific, continuous concept of life, sociality, or the physical universe, although, as N. Katherine Hayles suggests in *My Mother Was a Computer*, arguments to the contrary are certainly part of the control episteme.[10] Rather, this book is an inquiry into the ways in which certain digital conceptualizations of those phenomena emerge, are normalized, and function within social, political, and cultural practices. In this sense, the movement from digital systems to control is comparable to the movement in the concept of networks that, for Luc Boltanski and Ève Chiapello, underpins their "new spirit of capitalism." For Boltanski and Chiapello, the contemporary ubiquity of the word *network*, formerly associated with the either technical distribution of resources (water, electricity) or with secret organizations (resistance, trafficking) amounts to a "rehabilitation" that can be understood only in the context of the new working methods facilitated by computer technologies, but that cannot be reduced to these technologies and methods.[11] Digitality, as it functions under the sign of control, comes to describe not only a set of technologies or logical operations but also a fundamental condition. To exist, from the point of view of control, is to be digital—or, in Friedrich Kittler's words, after the emergence of digital signal processing, "only what can be configured as a switching circuit exists."[12] This ontological digitality, separated from the machines and interfaces with which it has become synonymous, entails a fundamental process of discretization that can be purely conceptual as much as it can enable particular technological processes.[13] In the same way, digitality moves from a specific system of representation and technical processing to a set of generalized metaphors. The historical emergence of control, as it is characterized in this book, accounts for the processes through which this generalization of digitality takes place.

It is in the context of digitality's becoming-general that the tensions raised at the outset of this chapter—between "creative" information work and the expansion of paid and unpaid labor as well as between the "immaterial," frictionless information society and the constant violence of exclusion, expulsion, and incarceration that is the corollary of this society—must be situated. Digitality promises to render the world legible, recordable, and knowable via particular numeric and linguistic constructs. For this rendering of the world to take place, however, there must be processes of capture, definition, optimization, and filtering that necessarily implement a distinction between those aspects of the world that are intended and included **(p.xx)** within a given digital representation and those that are excluded or filtered out.

The process of digitization as well as the necessary process of exclusion it entails can be illustrated through the technique of pulse code modulation (PCM). Developed at Bell Laboratories in 1943 following the discovery of a patent held by Alec H. Reeves since 1938, PCM represents the first technique for the digitization of analog signals such as speech, recorded sound, and images.[14] PCM consists of two stages. The first stage samples the analog signal, dividing it into a number of discrete units that must be at least double the signal's highest frequency. There is, then, an immediate imposition of uniform, discrete steps onto continuous matter. As B. M. Oliver, J. R. Pierce, and Claude Shannon put it, "[T]o transmit a band-limited signal of duration T, we do not need to send the entire continuous function of time. It suffices to send the finite set of $2WoT$ independent values obtained by sampling the instantaneous amplitude of the signal at a regular rate of $2W$o samples per second."[15] This first stage results in "a definite and limited number of amplitudes per unit of time which replace the original wave in subsequent operations."[16] It also allows for the exclusion of "noise" by dividing the signal into "desired" bands and those that fall outside of them: as the communication engineer W. M. Goodall puts it, "When the sampling frequency is at least twice the highest frequency present in the original wave, the resulting distortion falls outside the desired band and can be removed by a low-pass filter in the output of the system."[17] The second stage of PCM quantizes the signal's amplitude by reducing its total field of possibility to a fixed set of permitted values, each expressed as a sequence of on/off states.[18] Like the sampling stage, this second stage is founded on a process of limitation and, by extension, exclusion. "By quantizing," Oliver, Pierce, and Shannon write, "we limit our "alphabet."[19] These processes of filtering, averaging, and excluding, which are inherent to the digitization of continuous phenomena, appear innocuous enough when applied to telephone or television signals but become fatal when the computer is idealized and deployed as a model for socioeconomic management.

In "There Is No Software" Friedrich Kittler observes that the tension between the ideal principle of computation as theoretically universal and the basic procedures of excluding or filtering that material practices of computation actually entail is fundamental to digital culture, being traceable at least to Alan Turing's foundational 1936 paper on computable numbers and their applicability. Considering the gap between the symbolic register of the computer and the material fullness of the real, Kittler writes that

> **(p.xxi)** only in Turing's paper "On Computable Numbers with an Application to the *Entscheidungsproblem*" does there exist a machine with unbounded resources in space and time, with infinite supply of raw paper and no constraints on computation speed. All physically feasible machines, in contrast, are limited by these parameters in their very code. The inability of Microsoft DOS to tell more than the first eight letters of a file name such as WordPerfect gives just a trivial or obsolete illustration of a problem that has provoked not only the ever-growing incompatibilities between the different generations of

> eight-bit, sixteen-bit and thirty-two-bit microprocessors, but also a near impossibility of digitizing the body of real numbers formerly known as nature.[20]

In other words, although a concept of the computer as universally inclusive might be theoretically possible, the notion that real (which is to say non-discrete) phenomena can be digitized without exclusion is precluded by the materiality of actual computing machines. The persistent reformulation of the computer from finite, concrete technology to universal metaphor (for the brain, for the subject, for the economy, for society) lies behind the emergent logic of control and as such is central to the historical phenomena addressed in this book.

Addressing this construction of digitality as metaphor imposes a specific set of methodological concerns. The pejorative concept "vapor theory" has been central to the development of materialist media theories, especially those pertaining to electronic digital computers.[21] Vapor theory, in these accounts, describes critical analyses of technology that are based on vague metaphors rather than on rigorous materialist engagement—or, as Peter Lunenfeld puts it, "critical discussions about technology untethered to the constraints of production."[22] Yet conceptual deployments of computer technology that are not tethered to the constraints of their materiality proliferate in the socioeconomic formulations of the past sixty years, from ideological deployments of genetics that frame market competition as natural to ideas such as that of the network society in which social actors are conceived of as interrelating like computers.

Control thus begins from the following principle, which necessitates a synthetic engagement with *both* vague metaphors *and* materialist analysis: even in the age of so-called immaterial economies, the dominant mode of production cannot be reduced to the dead labor of machinery but rather rests on a complex of technical processes and socioeconomic and cultural logics that rely on vague metaphors drawn from such technologies for their conceptual efficacy. In this arrangement, the technical processes facilitate specific working practices, while the vague metaphors allow for the constant expansion of processes of valorization as the subject **(p.xxii)** is reconceptualized as both a communication system and a component in such a system. Communicative acts are recast and exploited as labor, and already existing forms of labor are recast as communication. If the vagueness of the human–machine metaphor is central to its mobilization by capital, one cannot discard it but instead must identify it (and thus describe it) and then critique it through (1) historical and material specificity and (2) the extraction of a political valence from the specific account. Put simply, vapor theory cannot be ignored when it constitutes the cultural layer of the dominant mode of production; it must be engaged and traced both to its origins and to the desires that it reveals.

This book seeks to identify control as episteme (rather than as confined to certain fields) by locating its historical grounding and its foundational logic across a diverse body of objects and practices, from cybernetics to economic theories and management styles, to concepts of language and subjectivity, to literary texts, films, and video games. This breadth is essential because when the digital is brought to bear on concepts such as labor, subjectivity, and collectivity, it constitutes not only a set of technical processes but also a social logic that reaches beyond computational technologies. This commingling of the technical and the social is here defined as foundational to the logic of control. Control both defines and instrumentalizes individual actors and groups, whose conditions of social existence are now premised on statistical predictive models and decisional states that rest on a conceptual as well as a technical digitization of the world. Following Fredric Jameson's lesson that explicit political content cannot, taken alone, divulge the true political implications of a cultural object,[23] it thus becomes

necessary to look not only at but also through the specific technical objects, economic practices, industrial formations, political ideals, and organizational diagrams of the present in order to trace the digital logic of control that animates and facilitates all of these phenomena under the banner of the so-called information economy (or whichever epithet one chooses to apply to this era).

Notes:

(1.) For an indicative sample of these periodizing texts, see Alain Touraine, *The Postindustrial Society: Tomorrow's Social History: Classes, Conflicts, and Culture in the Programmed Society* (New York: Random House, 1971); Daniel Bell, *The Coming of Post-industrial Society: A Venture in Social Forecasting* (New York: Basic Books, 1973); Marc Porat, *The Information Economy: Definition and Measurement* (Washington, DC: US Department of Commerce, 1977); Alvin Toffler, *The Third Wave* (New York: Bantam Books, 1980); Fredric Jameson, "Postmodernism, or, the Cultural Logic of Late Capitalism," *New Left Review* 146 (1984): 59–92; Ash Amin, *Post-Fordism: A Reader* (Cambridge, UK: Blackwell); Manuel Castells, *The Rise of the Network Society* (Cambridge, UK: Blackwell, 1996); Wendy Brown's work from "Neo-Liberalism and the End of Liberal Democracy," *Theory and Event* 7.1 (2003) to *Undoing the Demos* (Cambridge, MA: MIT Press, 2015); David Harvey, *A Brief History of Neoliberalism* (Oxford: Oxford University Press, 2005); Luc Boltanski and Ève Chiapello, *The New Spirit of Capitalism*, trans. Gregory Elliott (London: Verso, 2005); Michael Hardt and Antonio Negri, *Empire* (Cambridge, MA: Harvard University Press, 2000).

(2.) For these works, see note 1.

(3.) See Norbert Wiener, *Cybernetics, or Control and Communication in the Animal and the Machine* (1948; 7th ed., New York: Wiley, Paris: Herman et Cie, 1949). For accounts of the study and development of control systems before Wiener, see Stuart Bennett, *A History of Control Engineering 1800–1930* (London: Peter Peregrinus, 1979) and *A History of Control Engineering 1930–1955* (London: Peter Peregrinus, 1993); James R. Beniger, *The Control Revolution: Technological and Economic Origins of the Information Society* (Cambridge, MA: Harvard University Press, 1989); and David R. Mindell, *Between Human and Machine: Feedback, Control, and Computing before Cybernetics* (Baltimore: Johns Hopkins University Press, 2002).

(4.) For an account of the intersections of technology and governmentality in the terminology of control, see G. T. Guilbaud, *What Is Cybernetics?* trans. Valerie MacKay (London: Heinemann, 1959), 1–7.

(p.170) (5.) Beniger, *The Control Revolution*, vi.

(6.) Ibid., 37–38.

(7.) Karl Deutsch, *The Nerves of Government: Models of Political Communication and Control* (1963; New York: Free Press, 1966), 76.

(8.) Tiqqun, "The Cybernetic Hypothesis" (in French), *Tiqqun 2* (2001), 53, 55. My thanks go to the anonymous translator(s) at tiqqun.jottit.com and Rachel Shapiro for the translation of passages from this article.

(9.) Bernard Stiegler, *For a New Critique of Political Economy*, trans. Daniel Ross (Cambridge, UK: Polity, 2010), 31–32. Stiegler goes on to show how grammatization accounts for recording systems such as writing and technical media as well as for the discretization and social reorganization of manual labor by way of machines:

> [W]ith the industrial revolution the process of grammatization constituting the history of mnemotechnics *suddenly surpasses the sphere of language* that is, also, the sphere of logos.… [T]he process of grammatization invests bodies. And in the first place, it discretizes the gestures of producers with the aim of making possible their automatic reproduction—while at the very same moment there also appear those machines and apparatuses for reproducing the visible and the audible that so caught the attention of Walter Benjamin, machines and apparatuses which grammatized perception and, through that, the affective activity of the nervous system. (32–33)

(10.) "The appearance of the Computational Universe at a moment in human history when computers have achieved unparalleled scope and importance is obviously not coincidental" (N. Katherine Hayles, *My Mother Was a Computer* [Chicago: University of Chicago Press, 2005], 3). Although the concept of the computable universe addressed by computer scientists and physicists such as Konrad Zuse, Edward Fred-kin, and Stephen Wolfram clearly forms part of the historical logic addressed in this book, the focus here is on the conflation of computation (often in fuzzy, metaphorical form) and socioeconomic thought and practice under late capitalism rather than on fundamental questions of physical reality. A prototypical concept of the computable universe does occur in Charles Babbage's *Ninth Bridgewater Treatise* (1838); this concept of the universe is instructive when considering Babbage's intertwined work on political economy and computing machines and is thus addressed in chapter 1. For versions of the computable-universe thesis, see Konrad Zuse, *Rechnender Raum* (Braunschweig, Germany: Friedrich Vieweg & Sohn, 1969); Edward Fredkin, "Finite Nature," in *Proceedings of the XXVIIth Rencotre de Moriond* (Gif-sur-Yvette, FR: Editions Frontieres, 1992), and "Introduction to Digital Philosophy," *International Journal of Theoretical Physics* 42.2 (2003): 189–247; and Stephen Wolfram, *A New Kind of Science* (Champaign, IL: Wolfram Media, 2002).

(11.) Boltanski and Chiapello, *The New Spirit of Capitalism*, 104.

(12.) "[W]eil nur ist, was schaltbar ist" (Friedrich Kittler, "Real Time Analysis, Time Axis Manipulation" [in German], in *Draculas Vermächtnis: Technische Schriften* [Leipzig: Reclam, 1993], 192).

(p.171) (13.) David Golumbia's concept of computationalism—a set of beliefs in the power and novelty of computation that allows it to pass for a radical agent of change while reinforcing multiple forms of instrumental reason and existing political and economic inequalities—is exemplary in tracking some of the ways in which this conceptual form of digitality is manifested. See David Golumbia, *The Cultural Logic of Computation* (Cambridge, MA: Harvard University Press, 2009).

(14.) See Alec H. Reeves, "Electric Signaling System," US Patent 2, 272, 070, filed November 22, 1939, and M. D. Fagen, ed., *A History of Engineering and Science in the Bell System*, vol. 2 (New York: Bell Telephone Laboratories, 1975), 316.

(15.) B. M. Oliver, J. R Pierce, and C. E. Shannon, "The Philosophy of PCM," *Proceedings of the Institute of Royal Engineers* 36.11 (1948): 1324.

(16.) W. M. Goodall, “Television by Pulse Code Modulation,” *Bell Systems Technical Journal* 30.1 (1951): 33.

(17.) Ibid.

(18.) Oliver, Pierce, and Shannon, “The Philosophy of PCM.”

(19.) Ibid., 1324.

(20.) Friedrich Kittler, “There Is No Software,” in *Literature, Media, Information Systems* (Amsterdam: G&B Arts International, 1997), 152. In making this point, Kittler quotes the physicist Brosl Hasslacher at length:

> [W]e use digital computers whose architecture is given to us in the form of a physical piece of machinery, with all its artificial constraints. We must reduce a continuous algorithmic description to one codable on a device whose fundamental operations are countable, and we do this by various forms of chopping into pieces, usually called discretization … The compiler then further reduces this model to a binary form determined largely by machine constraints.
>
> The outcome is a discrete and synthetic microworld image of the original problem, whose structure is arbitrarily fixed by a differencing scheme and computational architecture chosen at random. The only remnant of the continuum is the use of radix arithmetic, which has the property of weighing bits unequally, and for nonlinear systems is the source of spurious singularities.
>
> This is what we actually do when we compute up a model of the physical world with physical devices. This is not the idealized and serene process that we imagine when usually arguing about the fundamental structures of computation, and very far from Turing machines.

Kittler incorrectly cites Hasslacher’s paper as “Algorithms in the World of Bounded Resources,” but the correct title is “Beyond the Turing Machine” (quoted in “There Is No Software,” 152). Yuri Gurevich’s essay “Algorithms in the World of Bounded Resources” appears directly before Hasslacher’s “Beyond the Turing Machine” in Rolf Herken, ed., *The Universal Turing Machine: A Half-Century Survey* (Oxford: Oxford University Press, 1988), 407–416 and 417–434.

(21.) See Peter Lunenfeld, *Snap to Grid: A User’s Guide to Digital Arts, Media, and Cultures* (Cambridge, MA: MIT Press, 2001); Geert Lovink, *Dark Fiber* (Cambridge, MA: MIT Press, 2002); and Alexander R. Galloway and Eugene Thacker, *The Exploit: A Theory of Networks* (Minneapolis: University of Minnesota Press, 2007).

(p.172) (22.) Lunenfeld, *Snap to Grid*, 174.

(23.) Fredric Jameson, “Class and Allegory in Contemporary Mass Culture: *Dog Day Afternoon* as a Political Film,” *College English* 38.8 (1977): 846.